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ABSTRACT

Schools in the hot and humid zones of the Asian region are narrow to ensure good ventilation. The purpose of this report is to show that it is possible, through appropriate design, to obtain sufficient breeze for thermal comfort in buildings as wide as 15 meters. Some of the conclusions of a study of the subject are summarized. The summary is followed by a series of illustrations showing the principles of air flow; and the effects of louvers, window size, vertical projections on the windward wall, adjacent buildings, and landscaping on ventilation. (Author/MLF)

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INDUCED AIR MOVEMENT FOR WIDE-SPAN SCHOOLS IN HUMID ASIA

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INTRODUCTION

In order to make sure that schools in the hot-humid zones of the Asian Region are as comfortable as possible, school buildings have overhanging roofs which provide shade. The buildings are kept as narrow as possible so that the breezes can blow through easily, from one side of the building to the other. Sometimes, as in Sri Lanka, the schools have completely open sides to encourage the passage of breeze. In other places, the windows are usually very large so that, when open, the wind has the maximum opportunity to blow through the building.

This tendency to build long, narrow buildings to ensure good ventilation is often a constraint to the educator and to his building designer, both of whom might prefer the wider type of space that provides greater possibilities for innovative groupings of students, and consequently, innovative methods of education.

The purpose of this Digest is to show that it is possible, through appropriate design, to obtain sufficient breeze for thermal comfort in buildings as wide as 15 metres. Air movement over the human body in hot humid conditions promotes evaporation of sweat and induces a cooling sensation. Hence the flow of air indoors should be directed downward through the occupancy zone.

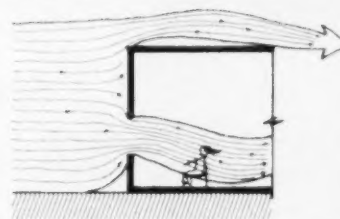
Some of the conclusions of an exhaustive study of the subject (Unesco, Educational Building Report, No. 6, *Induced air movement to improve thermal comfort in wide span educational buildings in the hot humid tropics*) are summarized below and the summary is followed by a series of illustrations that will help the designer to design buildings with a span of up to 15 metres for thermal comfort.

PRINCIPLES OF FLOW OF AIR

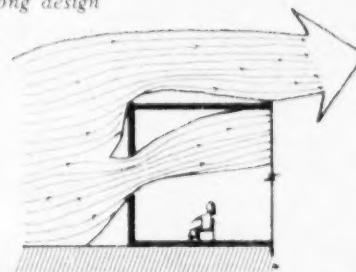
1. Air flows from high-pressure to low-pressure regions.
2. Air possesses inertia and, once set in motion, tends to continue to flow in its initial direction until acted upon by some external force or until it meets some obstruction like a wall, a tree or a hedge.
3. Air flows along the path of least resistance. In the case of tall buildings where the height-to-length ratio of the windward projection is greater than unity, the flow deflection is lateral on the lower parts of the building and is vertical on the upper parts. On the other hand, in the case of a low building with a height-to-length ratio of less than unity, the flow around the sides is negligible compared to that over the top.

DESIGN FOR ACHIEVING THERMAL COMFORT

Correct design



Wrong design



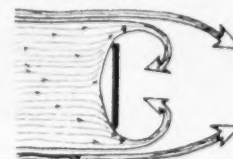
PRINCIPLES OF FLOW OF AIR



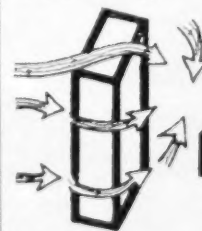
Unobstructed flow of air



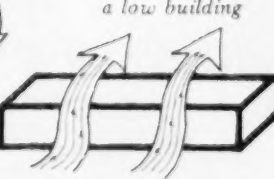
Air deflection by an obstruction



Air flow around a tall building

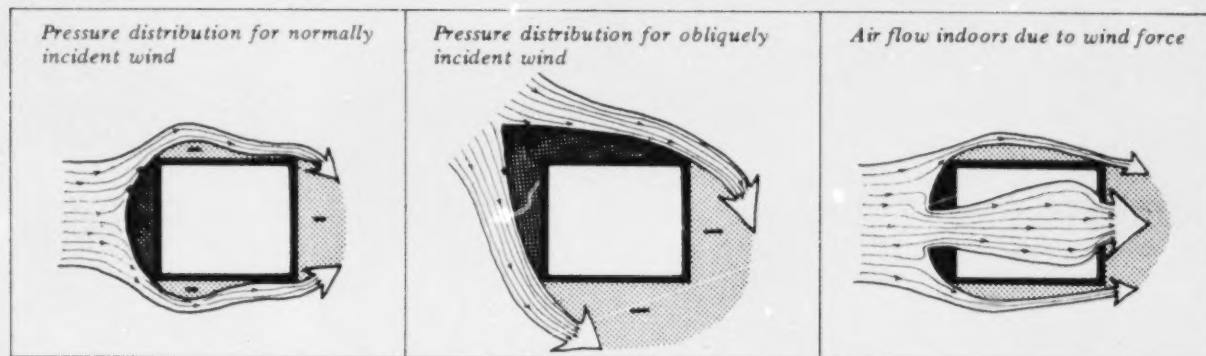


Air flow around a low building



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WIND FORCE



MOTIVE FORCES

Wind force

When wind strikes normally on a building, a region of high pressure (+ve) is developed on the windward wall while negative pressure is developed on the two adjacent sides and over the entire leeward side.

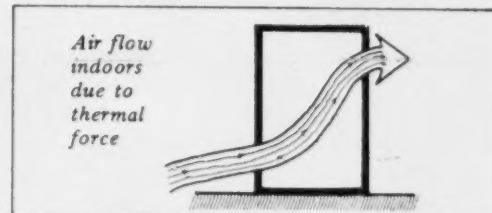
An obliquely incident wind creates positive pressure on the wind-facing walls and negative pressure on the opposite walls.

Air enters buildings through openings located in the positive pressure region and escapes through openings located at the negative pressure region.

Thermal force

Air enters the building through the lower opening and escapes through the opening at a higher level.

THERMAL FORCE



WINDOW SIZE

Window width

The average indoor air speed increases rapidly by increasing the width of the window up to about one-half of the wall width; beyond that the increase is in much smaller proportion than the increase in window width.

Window height

The average indoor wind speed in the working zone is maximum when window height is 1.1 m. Further increase in window height promotes air motion at top level of the window, but does not provide additional benefit as regards air motion in the occupancy zone in buildings.

Sill height

Maximum air motion at a particular plane is achieved by keeping the sill height at 85 per cent of the height of the plane.

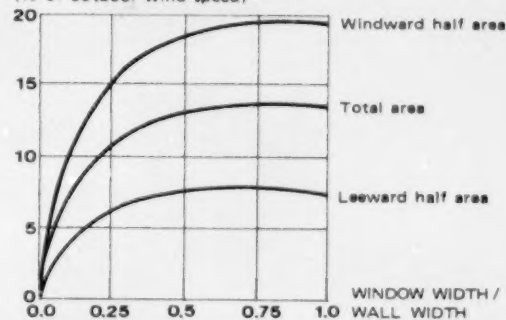
EFFECT OF LOUVERS

Horizontal louver; i.e., a sun shade, a top window, deflects the incident wind upward and reduces air motion in the zone of occupancy.

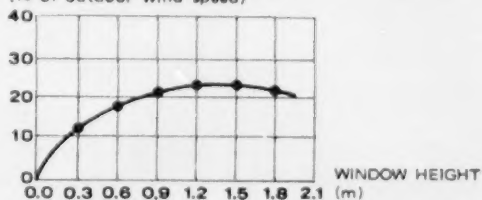
A slot between the wall and horizontal louver prevents upward deflection of air indoors.

Roof overhangs help to promote air motion in the working zone inside buildings.

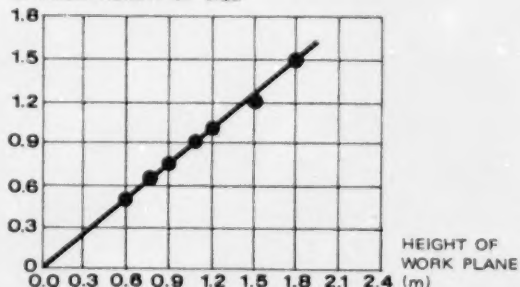
AVERAGE INDOOR WIND SPEED
(% of outdoor wind speed)



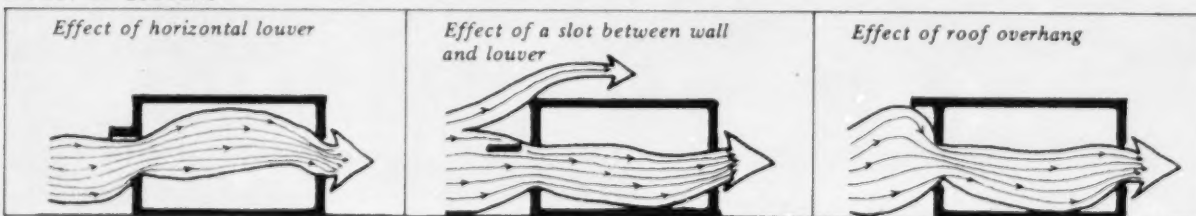
AVERAGE INDOOR WIND SPEED
(% of outdoor wind speed)

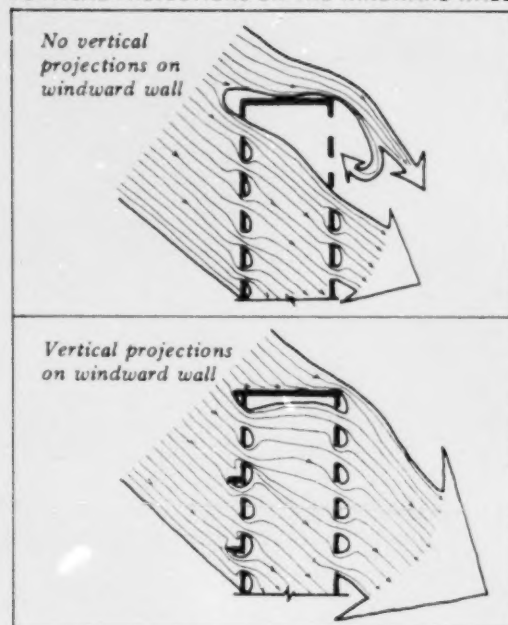


OPTIMUM HEIGHT OF SILL

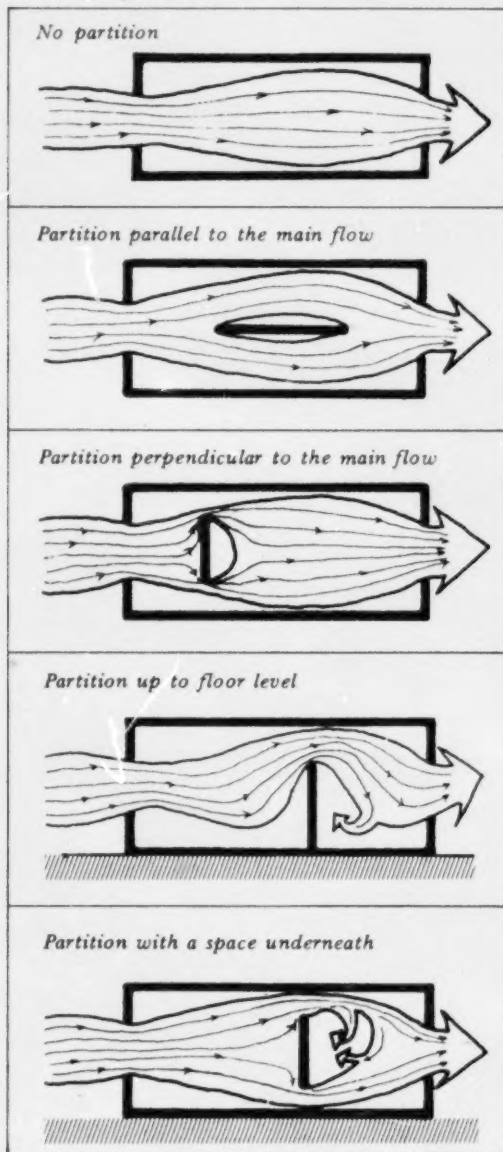


EFFECT OF LOUVERS





PARTITION EFFECT



VERTICAL PROJECTIONS ON THE WINDWARD WALL

A wind shadow is created behind a windward wall when wind strikes obliquely on the building. In schools where uniform air flow is desired over the entire room area, occurrence of any dead zone may be prevented by vertical projections on the wall.

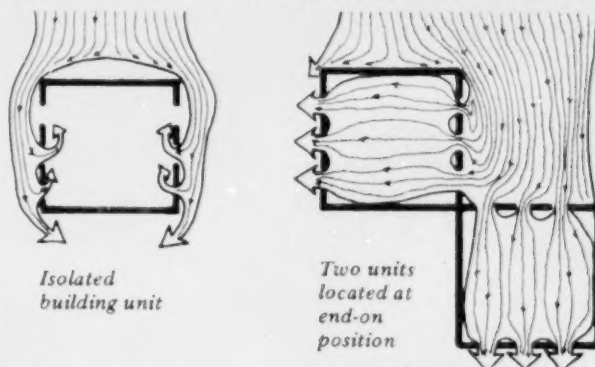
PARTITION EFFECT

A partition placed parallel to the incident wind has little influence on the pattern of air flow, but when located perpendicular to the main flow, the same partition creates a wind shadow.

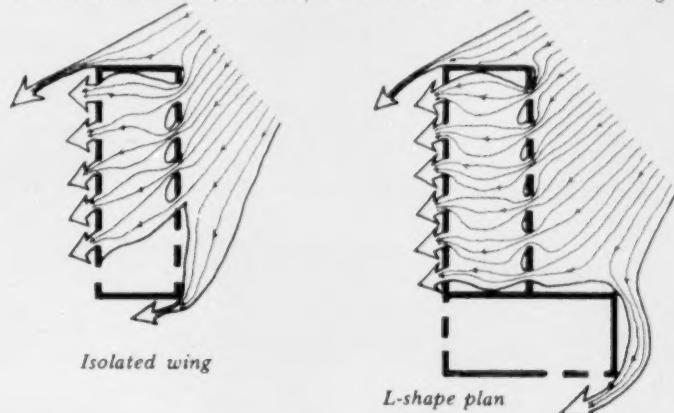
Provision of a partition with spacing of 0.3 m. underneath helps to improve air motion near floor level in the leeward compartment.

PLAN FORM

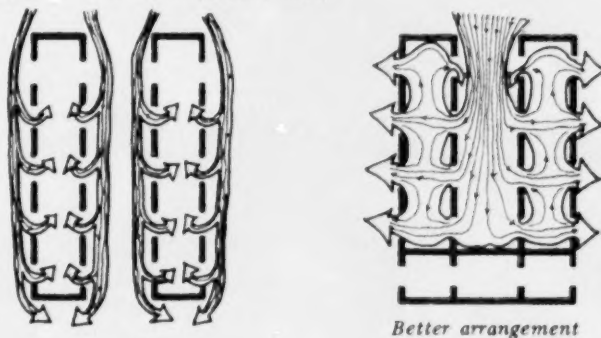
Air motion in a building unit having windows tangential to the incident wind is accelerated when another unit is located at end-on position on the downstream side.



A small wing at right angles to a longer wing on the windward side helps to improve air motion inside the wing.



Air motion in two wings oriented parallel to the prevailing breeze is improved by connecting them with a block on the downstream side.

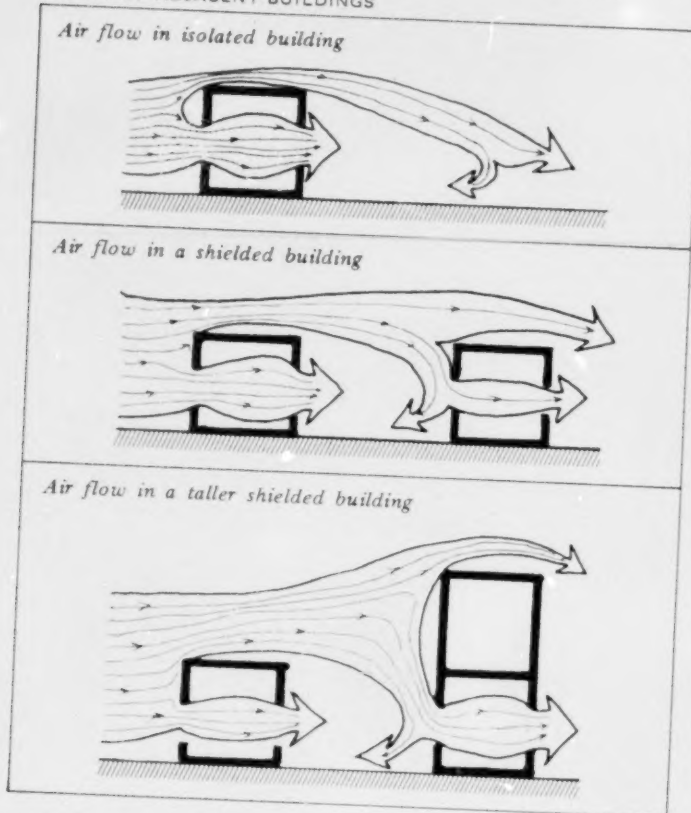


EFFECT OF ADJACENT BUILDINGS

Air motion in a building is not affected by constructing another building of equal or less height on the leeward side, but it is slightly reduced if the leeward building is taller than the windward block.

Air motion in a shielded building is less than that in an unobstructed building, but the shielding effect is diminished by raising the height of the shielded building.

EFFECT OF ADJACENT BUILDINGS



EFFECT OF LANDSCAPE ELEMENTS

Hedges and shrubs deflect the air away from the inlet openings and cause a reduction in air motion indoors. These elements should not be planted at a distance of more than 2 or 3 m. from the building because the induced air motion is reduced to a minimum in that case. Air motion in the leeward part of the building can be enhanced by planting a low hedge at a distance of 2 m. from the building.

Trees with a large foliage mass, having the trunk bare of branches up to the top level of window, deflect the outdoor wind downward and promote air motion in the occupancy zone inside the buildings.

Ventilation conditions indoors can be ameliorated by constructing buildings on an earth mound having a surface with a slope of 10° on upstream side.

EFFECT OF LANDSCAPE ELEMENTS

